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Mandarin *wh*-conditionals as interrogative conditionals *

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Abstract This paper examines *wh*-conditionals in Mandarin Chinese. It argues that *wh*-conditionals involve embedding two questions within a conditional, one in the antecedent and one in the consequent. Transition from a Hamblin/Karttunen question meaning to a conditional semantics is achieved by answerhood operators. The meaning obtained in this way is simple and intuitive: answers to the antecedent question already contains information to answer the consequent question.

Keywords: *wh*-conditionals, questions, conditionals, correlatives, Mandarin Chinese

1 Introduction

Wh-conditionals refer to a type of construction found in Mandarin (Cheng & Huang 1996; Chierchia 2000) and Udihe¹ (Nikolaeva & Tolskaya 2001: 763, Baek 2016: Chapter 6), the defining property of which is that they contain one or more *wh*-phrases in the antecedent clause matched by an equal number of seemingly co-varied *wh*-phrases in the consequent. Below, (1) is a Mandarin illustration,² where paraphrases (1a) (Cheng & Huang 1996; Chierchia 2000) and (1b) (Crain & Luo 2011; Huang 2010) indicate two ways of thinking about its semantics.

- (1) Zhangsan qing le shei, Lisi jiu qing le shei.
Zhangsan invite ASP who Lisi then invite ASP who
- a. If Zhangsan invited X, Lisi invited X.
 - b. Lisi invited who(ever) Zhangsan invited.

The current paper concerns Mandarin *wh*-conditionals, but instead of going immediately after them, we will start with a general introduction of Mandarin *wh*-phrases. As will be clear in a minute, our endeavor to keep a unified story of Mandarin *wh*-expressions creates certain challenges for analyzing *wh*-conditionals.

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1 A Tungusic language spoken in the southern part of Russian Far East.

2 *Jiu* is an adverbial conditional marker that usually appears in the consequent of a typical conditional in Mandarin. I will treat it as semantically vacuous, and gloss it as ‘then’.

Besides their role in interrogatives as question words as in (2a), Mandarin *wh*-items have non-interrogative uses: they are interpreted as simple indefinites below negation in (2b), as epistemic indefinites in the presence of modals in (2c), and they contribute to universal force in the *wh-dou* construction (Cheng 1995; Lin 1996) in (2d).

- (2) *Mandarin wh-expressions* cf. Chierchia & Liao 2014: 1
- | | |
|---|---------------|
| <p>a. Zhangsan qing le <u>shei</u>?
 Zhangsan invite ASP who
 ‘Who did Zhangsan invite?’</p> | INTERROGATIVE |
| <p>b. Zhangsan mei qing <u>shei</u>.
 Zhangsan NEG invite who
 ‘Zhangsan didn’t invite anyone.’</p> | NEGATIVE |
| <p>c. Zhangsan haoxiang chi le <u>shenme</u>.
 Zhangsan seem eat ASP what
 ‘Zhangsan might have eaten something.’</p> | EXISTENTIAL |
| <p>d. Zhangsan <u>shenme</u> dou gei le ni.
 Zhangsan what DOU give ASP you
 ‘Zhangsan has given you everything.’</p> | UNIVERSAL |

Crucially, Mandarin *wh*-phrases are restricted in their distribution (in words familiar to syntacticians, they need ‘licensing’): they are fine with negation (and other standard DE operators), modals and some focus adverbs like *dou* ‘even’, *ye* ‘also’, but are ungrammatical in positive episodic contexts as in (3). They are Polarity Sensitive Items (PSIs)³ (Cheng 1997; Lin 1996; Liao 2011).

- (3) * Zhangsan qing le shei.
Zhangsan invite ASP who
Intended: ‘Zhangsan invited someone.’

The polarity-sensitive property of Mandarin *wh*-phrases poses the following challenge to a successful analysis of *wh*-conditionals: if the *wh*-phrases therein are PSIs (as the literature suggests, eg. Cheng & Huang 1996: 133, Chierchia 2000: 36–37), how could they be licensed in the consequent of a conditional, a straightforward upward-entailing context, without triggering any epistemic effect?

Irene Heim (pc. to Cheng & Huang) already expresses this concern (Cheng & Huang 1996: 133). The usual response one can find in the literature is that both

³ We construe the term PSI very broadly as including negative polarity items like *ever*, free choice items like *any/irgendein* as well as epistemic indefinites, following Chierchia 2013.

the antecedent-*wh* and the consequent-*wh* are licensed — as polarity items — by a covert unselective binder (Cheng & Huang 1996: 133, Chierchia 2000: 36-37). This now seems unsatisfactory in view of our deepened understanding of the polarity system, due to Chierchia 2013.

A second challenge is more specific to the Chierchia-style system of PSIs (Chierchia 2013), within which a unified analysis of Mandarin *wh*-phrases is presented in Liao 2011 and Chierchia & Liao 2014. In Chierchia’s system, PSIs are essentially existentials (that obligatorily trigger alternatives), but how could an existential start to sound like a definite (or a bound pronoun) — by co-varying with an antecedent-*wh* — in the consequent of a *wh*-conditional?

Bearing the challenges in mind, we will look at *wh*-conditionals in detail. Below, after reviewing previous accounts in §2, I present a novel analysis in §3 that treats *wh*-conditionals as interrogative conditionals. Besides immediately explaining the *wh*-challenge, the new proposal leads us to the discovery of a wide range of interrogative properties of *wh*-conditionals, to be discussed in §4. Finally, §5 concludes.

2 Previous analyses

Two very different conceptualizations of *wh*-conditionals have been proposed. One sees *wh*-conditionals as involving donkey binding (Cheng & Huang 1996; Chierchia 2000), the other relativization (Huang 2010; Crain & Luo 2011).⁴ The two approaches assign distinct meanings to *wh*-conditionals, to which we turn now.

2.1 Unselective binding

Those who see *wh*-conditionals as donkey sentences usually use unselective binding to get the truth-condition shown in (4).

$$(4) \quad \llbracket (1) \rrbracket = 1 \text{ iff } \forall_x [\text{invite}(zs, x) \rightarrow \text{invite}(ls, x)]$$

There are two ways in the literature to get (4) compositionally. For Cheng & Huang (1996), *wh*-words in a *wh*-conditional are treated as Heimian variables (Heim 1982) and a (covert) quantificational adverb unselectively bind them. For Chierchia (2000), the *wh*-items are existential quantifiers, but can be *existentially disclosed* (Dekker 1993) and thus bound by the quantificational adverb in a *wh*-conditional.

2.2 Correlative/free relative

Instead of seeing *wh*-conditionals as donkey sentences, Crain & Luo (2011) take them to be kin to correlatives/free relatives and (1) to have the truth-condition in (5).

⁴ More syntactically oriented approaches include Bruening & Tran 2006 and Cheung 2006.

$$(5) \quad \llbracket (1) \rrbracket = 1 \text{ iff } \text{invite}(\text{ls}, \sigma x[\text{invite}(\text{zs}, x)])^5$$

There are several ways of achieving (5) compositionally. The standard treatment of correlatives, following Dayal 1996 is to take the antecedent/correlative-clause as a lifted definite (cf. Jacobson’s (1995) treatment of free relatives) and the consequent/matrix-clause as the predicate, the two composed by functional application. In the case of *wh*-conditionals, the antecedent in (1) will denote $\lambda P.P(\sigma x[\text{invite}(\text{zs}, x)])$ and the consequent $\lambda x.\text{invite}(\text{ls}, x)$ (Crain & Luo 2011: 173, Huang 2010: 46). Such analyses are called FR-based analyses in the paper.

Note that both accounts fail to explain the use of *wh*-morphology in *wh*-conditionals: unselective binding fails because it needs to license *wh*-phrases — being polarity items — in the consequent of a conditional; FR-based analyses fail because they need Mandarin *wh*-phrases to be relative pronouns, which however is implausible: outside *wh*-conditionals, *wh*-words are never involved in any form of relativization such as relative clause formation or single free relatives. A new analysis is called for.

3 The proposal

We propose that *wh*-conditionals are interrogative conditionals, which differ from ordinary conditionals simply in that their antecedents and consequents both embed questions. We then assume a semantics of conditionals/counterfactuals that utilizes exemplifying situations (Fine 2012), which helps us to keep track of the individuals that exist in a situation. Finally, transition from Hamblin/Karttunen-questions to conditionals is achieved by answerhood operators (Heim 1994; Dayal 1996; Beck & Rullmann 1999). The main intuition behind this proposal is that a *wh*-conditional express that answers to the antecedent question already contain enough information to answer the consequent question. Next come some details.

3.1 *Wh*-clauses as Hamblin/Karttunen-questions

We take the *wh*-clauses in *wh*-conditionals to be questions and adopt a Hamblin/Karttunen semantics of questions (Hamblin 1973; Karttunen 1977), where a question denotes a set of propositions — the set of its possible answers. To illustrate, suppose there are exactly three people besides Zhangsan in the domain — Bill, Mary and Sue, and that inviting is irreflexive; then the question in (6) denotes the set of propositions in (7).

$$(6) \quad \text{Who did Zhangsan invite?}$$

⁵ This is the official semantics Crain & Luo (2011: 173) give, under their (19e). Their informal paraphrase, which points to treating *wh*-conditionals as equatives, does not match their semantics.

$$(7) \quad \llbracket (6) \rrbracket = \left\{ \begin{array}{l} \lambda s. \text{Zhangsan invited Bill in } s, \\ \lambda s. \text{Zhangsan invited Mary in } s, \\ \lambda s. \text{Zhangsan invited Bill} \oplus \text{Mary in } s, \end{array} \right\}$$

Note that we take propositions to be sets of situations (not worlds), since we are going to adopt a situation-based semantics of conditionals in the next subsection.

3.2 A situation-based semantics of conditionals

The classical semantics of conditionals is based on possible worlds and similarity relations among them (Stalnaker 1968; Lewis 1973), as in (8); following Stalnaker 1975, we also take all conditionals (indicative and subjunctive/counterfactuals) to have the same core semantics.

- (8) $\llbracket \text{if } p \text{ then } q \rrbracket = 1$ at w^* iff all of the closest-to- w^* worlds in which p is true are worlds in which q is true.

Kratzer 1981b, 2012 present a semantics of conditionals based on premise sets as in (9). (9) is shown to be equivalent to (a version of) similarity-based ordering semantics (Lewis 1981).

- (9) $\llbracket \text{if } p \text{ then } q \rrbracket = 1$ at w^* iff every way of adding as many (propositional) facts of w^* to p as consistency allows reaches a point where the resulting set logically implies q . (Kratzer 2012: 180).

For the purpose of capturing the intuitively felt covariation of the two *wh*s in a *wh*-conditional, we adopt a semantics of counterfactuals due to Fine 2012, which uses situations/states.⁶

- (10) $\llbracket \text{if } p \text{ then } q \rrbracket = 1$ at w^* iff any possible outcome of an p -state at w^* contains a q -state.⁷

⁶ Three points need mentioning: first, Fine's situation semantics of conditionals has nothing to do with donkey binding but aims at providing a general theory of conditionals just as Stalnaker/Lewis/Kratzer — his main motivation being to invalidate substitution of logically equivalent antecedents and to validate simplification of disjunctive antecedents. Second, Fine's situation-semantics and Kratzer's (2014) situation-semantics have many differences (Fine To appear). But these differences are not relevant for our purposes so we choose to work with Kratzer's formulation. Some terminology: whenever Fine says s is a p -state or s exactly verifies p , Kratzer says s exemplifies p . Whenever Fine says s inexactly verifies p , Kratzer says p is true in s (and sometimes we will say s supports p). Finally, to make another simplification, we will talk about exemplifying situations and minimal situations interchangeably, which is justified in our case for we are not going to discuss propositions that are divisive (such as propositions involve mass nouns and negative noun phrases). Standard definition of minimality based on part-of applies for now, but will be revisited in the appendix.

⁷ Formally, $w \models A > C$ if $u \models C$ whenever $t \models A$ and $t \rightarrow_w u$ (Fine 2012: 237), where $>$ is the counterfactual symbol, \models exact verification, $>$ inexact verification, and $t \rightarrow_w u$ means extending t to u according to facts (cf. Kratzer's premise set) in w .

We may modify (10) in a way that brings out its similarity to the premise semantics in (9). Instead of adding premises into the antecedent proposition (its unit set), we use premises to enlarge our antecedent-situation. The resulting (11) is the semantics we will adopt for Mandarin conditionals, marked by *jiu*.

- (11) $\llbracket p \text{ jiu } q \rrbracket = 1$ at s^* iff $\forall s[s \in \text{MIN}\{s : p(s) = 1 \wedge C_{s^*}(s) = 1\} \rightarrow q(s) = 1]$,
where C is conversational background.⁸

In words: a Mandarin conditional $[p \text{ jiu } q]$ is true at s^* iff every minimal situation s such that p is true at s , coupled with the conversational background C obtained at s^* , is also a situation in which q is true.

Note that the semantics for conditionals in (11) looks different from the standard situation semantics of conditionals used in the donkey anaphora literature (Berman 1987; Heim 1990; von Stechow 1994; Elbourne 2005). Donkey-situation-semantics usually assigns (12) as the semantics of conditionals (see von Stechow 2004: (9)).

- (12) $\llbracket \text{if } p \text{ then } q \rrbracket = 1$ at s^* iff
 $\forall s[s \in \text{MIN}\{s : p(s) = 1 \wedge C_{s^*}(s) = 1\} \rightarrow \exists s'[s \leq s' \wedge q(s') = 1]]$

(11) is stronger than (12): (12) checks whether we can extend an antecedent situation into a consequent one, while (11) instructs us to construct a situation s based on the antecedent and the conversational background, and then to check whether s supports the consequent. Formally, since (11) can be obtained by strengthening the \leq on the right hand side of \rightarrow in (12) into $=$ (and consequents of \rightarrow are upward-entailing), (11) is stronger. While motivation for (12) comes entirely from donkey anaphora, the semantics in (11) is in the tradition of Lewis-Stalnaker-Kratzer and aims to provide a general theory of conditionals/counterfactuals. It is interesting to note that entirely different considerations lead to similar results. Finally, for our purposes, it is important not to use (12). This is because we will be trying to keep track of the individuals that exist in a situation, but allowing situation-extension — adding more individuals into a situation, that is — will make the task difficult.⁹

⁸ Two points need mentioning: first, we need the outmost MIN because we have decided to choose Kratzer-style non-exact situation semantics and classical \wedge . If we were to choose Fine-style exact situation semantics and non-classical \wedge , the MIN would not be necessary. A non-classical situation semantics \wedge looks like this: s verifies $A \wedge B$ iff s is the fusion $s_1 \sqcup s_2$ of a state s_1 that verifies A and a state s_2 that verifies B . Second, for simplicity, we are making a version of the Limit Assumption and the Unique Assumption (Stalnaker 1968); that is, for any s^* there is exactly one maximal premise set that is compatible with p ; we write (the conjunction of) the maximal premise set as C_{s^*} .

⁹ For a similar use of non-extending situation semantics, see Schwarz 1998 for an analysis of German reduced conditionals that employs a matching relation between events, following Rothstein 1995.

3.3 Answerhood operators as the glue

There is a tension here. Our semantics of conditionals works with propositions but the *wh*-clauses are sets of propositions. How to get from sets of propositions to propositions? We resort to answerhood operators (Heim 1994; Dayal 1996; Beck & Rullmann 1999). Specifically, we adopt Dayal's answerhood operator in (13), for its ability to deal with uniqueness, to be discussed in §4.3.

$$(13) \quad \text{ANS}(Q)(s^*) = \iota p \in Q[p(s^*) = 1 \wedge \forall q \in Q[q(s^*) = 1 \rightarrow p \subseteq q]]$$

Given an evaluation situation s^* , applying ANS to a question Q gives us the most informative proposition p in Q that is also true in s^* , if there is such a p (if no such p exists, $\text{ANS}(Q)(s^*)$ is undefined). To illustrate, suppose we are looking at last night's party s_{party} , and the host Zhangsan invited exactly two guests, Bill and Mary. In this case, applying ANS to the question in (14) and s_{party} gives us the proposition *that Zhangsan invited Bill and Mary*, as in (16).

(14) Who did Zhangsan invite?

$$(15) \quad \llbracket (14) \rrbracket = \left\{ \begin{array}{l} \lambda s. \text{Zhangsan invited Bill in } s, \\ \lambda s. \text{Zhangsan invited Mary in } s, \\ \lambda s. \text{Zhangsan invited Bill} \oplus \text{Mary in } s, \\ \dots \end{array} \right\}$$

$$(16) \quad \text{ANS}(\llbracket (14) \rrbracket)(s_{\text{party}}) = \lambda s. \text{Zhangsan invited Bill and Mary in } s$$

The proposition in (16) can be embedded under the semantics of conditionals provided in the previous subsection. We turn to such a semantics next.

3.4 *wh*-conditionals as interrogative conditionals

Now we can try to derive the meaning of *wh*-conditionals from the general semantics of Mandarin conditionals in (11), as in (17).

(17) *Semantics of wh-conditionals:*

$$\begin{aligned} & \llbracket \text{ANS}(Q_A)(s^*) \text{ jiu } \text{ANS}(Q_C)(s^*) \rrbracket = 1 \text{ in } s^* \\ & \text{iff } \forall s [s \in \text{MIN}\{s : \text{ANS}(Q_A)(s^*)(s) = 1 \wedge \text{PRE}(Q_C)(s) = 1\} \rightarrow \\ & \quad \text{ANS}(Q_C)(s^*)(s) = 1] \end{aligned}$$

In words: every minimal situation that supports the answer to Q_A in s^* and the presupposition of Q_C supports the answer to Q_C in s^* .

The connection of (17) to (11) is obvious. In both of them, we check whether every situation that exemplifies the antecedent coupled with the conversational background also supports the consequent. There are two differences: first, *wh*-conditionals embed questions while ordinary conditionals embed propositions; this

motivates the use of answerhood operators. Second, different from ordinary conditionals, *wh*-conditionals can be seen as having a nearly empty conversational background *C* — it has only the presupposition of the consequent in it. This isn't very hard to imagine, since conditionals do have different modal flavors (Kratzer 1981a, 2012), captured by varying choices of conversational backgrounds, and *wh*-conditionals are in this sense, a species of conditionals.

Next, notice the use of PRE in (17), which is a presupposition extractor. Here, we follow Karttunen & Peters 1976 in taking questions to carry existential presuppositions, and (17) says that the minimal antecedent *s* we select has to support both the antecedent answer and the existential presupposition of the consequent question. This is plausible, since presuppositions can be seen as requirements on prior contexts (and thus on the situations constructed out of them), and antecedents of conditionals are prior contexts for their consequents.

An illustration. Suppose in *s** Zhangsan invited John and Mary, and Lisi invited Bill and Sue. (1) is false in *s**: the minimal situation *s* that supports the answer to *who did Z invite?* in *s** and the presupposition of *Q_C* (an existential presupposition that *L invited someone*) consists of *zs*, *ls*, *j* ⊕ *m*; *s* does not support the answer to *Q_C* in *s** — that *L invited Bill and Sue*. In general, our semantics using minimal situations guarantees that the short answer to the consequent question is identical to the antecedent-short-answer, thus capturing the 'co-variation' of the two *wh*.

It needs to be mentioned that many technical details are bracketed away in (17). They will be discussed in the appendix.

4 The *wh*-puzzle and other interrogative properties of *wh*-conditionals

A question perspective not only solves the *wh*-challenge introduced in §1, but also helps us see a wide range of interrogative properties of *wh*-conditionals.

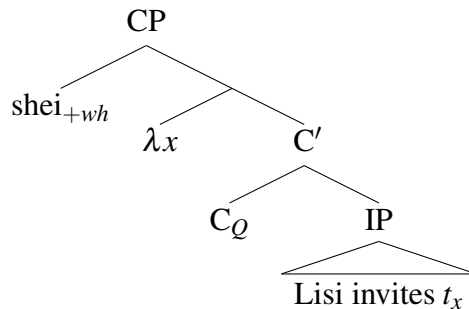
4.1 The use of *wh*-morphology

First of all, our analysis based on questions immediately explains the *wh*-licensing puzzle: *wh*-words in *wh*-conditionals (especially the consequent *whs*) are actually question words, not the type of polarity sensitive items that need downward entailing contexts (negative polarity items) or modal licensing (free choice items).

Even better, our analysis of *wh*-conditionals makes possible a unified analysis of Mandarin *wh* items. We follow Chierchia & Liao's (2014) proposal that all Mandarin *whs* are existentials: question-*wh* and polarity-*wh* share the same existential semantics, their difference being that polarity *whs* obligatorily trigger (domain) alternatives and thus need covert ONLY to exhaustify them (Chierchia 2013), while question *whs* do not trigger alternatives but need to appear in an interrogative context (in syntactic

parlance, its $+wh$ feature needs to be feature-checked by a question C head). We call the latter Karttunen-existentials, and the former Chierchia-existentials. One of the claims made in the paper is that the whs in wh -conditionals are Karttunen-existentials. To be concrete, (18) gives a way to compose the question meaning of *Lisi qing shei?* ‘who does Lisi invite?’ using Karttunen-existentials (Karttunen 1977) and the LF (with covert wh -movement) proposed by Huang (1982).

(18)



- a. $\llbracket IP \rrbracket = \lambda s. ls \text{ invites } x \text{ in } s$
- b. $\llbracket C_Q \rrbracket = \lambda q. p = q$
- c. $\llbracket shei \rrbracket = \lambda P \exists x [\text{people}(x) \wedge P(x)]$
- d. $\llbracket CP \rrbracket = \exists x [\text{people}(x) \wedge p = \lambda s. ls \text{ invites } x \text{ in } s]$
 $\xrightarrow{\lambda\text{-abstraction over } p} \lambda p \exists x [\text{people}(x) \wedge p = \lambda s. ls \text{ invites } x \text{ in } s]$

4.2 Quantificational invariability

Wh -conditionals do not exhibit quantificational variability, unexpected under unselective-binding. Consider (19), with an overt quantificational adverb *usually*.

- (19) Tongchang, Zhangsan qing shei, Lisi jiu qing shei.
 usually Zhangsan invite who Lisi then invite who
 Lisi usually invites who Zhangsan invites.
 $\not\approx$ Lisi invites most people that Zhangsan invites.

Unselective binding gives wrong truth conditions for (19), as shown in (20).

- (20) $\llbracket (19) \rrbracket = 1$ iff $\text{Most}_x [\text{invite}(zs, x)] [\text{invite}(ls, x)]$

According to (20), (19) is true iff Lisi invites most of Zhangsan’s invitees, which however is a meaning the sentence does not have. Instead, the sentence means for most relevant situations, Lisi invited *the* people Zhangsan invited. The two are different: suppose that there were three inviting situations/events in the past; in every situation, there was exactly one person that Zhangsan invited but Lisi didn’t. In this

case, (19) is false (they never invited the same group of people!) but (20) is most likely to be true. It is clear then that *tongchang* ‘usually’ quantifies over situations.

Adding a situation variable to (20), as in (21), does not save unselective binding. Intuitively, we want to quantify over situations that are large enough to hold all of Zhangsan’s invitees given a particular inviting event. (21), which breaks big situations into smaller individual-situation pairs, would be too fine-grained.

$$(21) \quad \llbracket (19) \rrbracket = 1 \text{ iff } \text{Most}_{x,s} [\text{invite}(zs, x, s)] [\text{invite}(ls, x, s)]$$

Quantificational invariability is expected under our proposal. Our *wh*s are existentials used in questions, and thus cannot be bound by adverbs of quantification. To be concrete, we propose that quantificational adverbs in *wh*-conditionals quantify over pragmatically determined subsituations of a topical situation (cf. Beck’s (2012) analysis of comparative correlatives). (19) thus has (22) as its analysis.

$$(22) \quad \llbracket (19) \rrbracket = 1 \text{ at } s^* \text{ iff} \\ \text{Most} [\lambda s. s \in \text{Cov}(s^*), \lambda s. \llbracket \text{ANS}(Q_A)(s) \text{ jiu } \text{ANS}(Q_C)(s) \rrbracket = 1 \text{ at } s]$$

In (22), we are looking at a plural situation s^* that has as its parts subsituations s (represented by $\text{Cov}(s^*)$) where Zhangsan and Lisi both threw a party. Then (22) requires that for most s , the information needed for answering the antecedent question (*who did Zhangsan invite at s?*) is enough to support the consequent question (*who did Lisi invite at s?*). Since we are quantifying over party-situations, not individuals, no quantificational variability is observed.

4.3 Uniqueness

Both the antecedent and the consequent of a *wh*-conditional exhibit uniqueness.

$$(23) \quad \begin{array}{l} \text{Zs qing } \underline{\text{na.liang.ge.ren}}, \quad \text{Lisi jiu } \text{qing } \underline{\text{na.liang.ge.ren}}. \\ \text{Zs invite which.two.CL.person Lisi then invite which.two.CL.person} \\ \text{Whichever two persons Zhangsan invites, Lisi invites them.} \end{array}$$

(23) has the presupposition that both Zhangsan and Lisi are presupposed to invite exactly two persons. Unselective binding does not capture this presupposition.

In our proposal, both the antecedent and the consequent have an ANS applied to a question, and this gives rise to uniqueness for both. We illustrate how this is achieved by considering the antecedent. Suppose there are three people John, Mary and Sue in the domain and *invite* is irreflexive. The antecedent question in (23) has the denotation in (24).

$$(24) \quad \llbracket \text{which 2.persons does Z invite?} \rrbracket = \left\{ \begin{array}{l} \lambda s. Z \text{ invites John} \oplus \text{Mary in } s, \\ \lambda s. Z \text{ invites John} \oplus \text{Sue in } s, \\ \lambda s. Z \text{ invites Mary} \oplus \text{Sue in } s \end{array} \right\}$$

Next, ANS applied to the question in (24) and to the evaluation index s^* , delivers the presupposition that there is a proposition in the question set that is true at s^* and entails all the other true-at- s^* propositions in the question set (see (13) for the formalization; intuitively, the presupposition just requires that the most informative answer be in the question denotation).

Now suppose Zhangsan invites three people, John, Mary and Sue, in s^* . All the propositions in (24) are true-at- s^* propositions, but none entails the other, and thus there is no proposition in the question set that is true at s^* and entails all the other true-at- s^* propositions in the question set. The presupposition of ANS is not satisfied. In general, for the presupposition of ANS to be satisfied in (24), Zhangsan has to invite exactly 2 persons. Uniqueness is captured.

4.4 Minimal *wh*-conditionals

Next let us consider (25), which has a upward scalar predicate *gou* ‘sufficient’ (Beck & Rullmann 1999).

- (25) duoshao qian gou chi kaoyao, wo jiu gei ni duoshao.
 how.much money sufficient eat roast.duck I then give you how.much
- a. I will give you the minimal amount of money sufficient to eat roast duck.
 - b. \neq for every amount of money x such that x is sufficient to eat roast duck, I will give you x .
 - c. \neq I will give you the maximal amount of money that is sufficient to eat roast duck.

(25) means that I will give you the minimal amount of money sufficient to eat roast duck. Unselective binding, delivering (25b), does not capture this.

Even FR-based analyses (relying on classical σ) do not work: σd . [d -amount of money that is sufficient to eat roast duck] will take us to (25c), which fares no better.

(25) is captured by our proposal using Dayal’s (1996) answerhood operator. ANS applied to the antecedent question in (25) picks out the most informative true proposition in the question set, which involves the minimal amount of money d_{MIN} that is sufficient to eat roast duck (for all amount of money d, d' such that $d < d'$, d is sufficient to eat roast duck $\subset d'$ is sufficient to eat roast duck). The conditional part then says that the situation contains d_{MIN} should be able to support the consequent answer; thus I have to give you the minimal amount of money that is sufficient to eat roast duck.

4.5 Mention-some *wh*-conditionals

Consider (26), the antecedent of which is interpreted existentially.

- (26) nar neng maidao jiu, wo jiu qu nar.
 where can buy liquor I then go where
 ‘I will go where I can get liquor.’
 a. = I will go to some place(s) where I can get liquor.
 b. \neq I will go to (all) the places where I can get liquor.

(26) intuitively means (26a): I will go to some place where I can get liquor. An σ -based free relative (or unselective binding with covert universal) however can only get us (26b). A similar example is given in (27), which obviously does not mean that I will marry all the rich people.

- (27) shei you qian, wo jiu jia gei shei.
 who have money I then marry to who
 ‘I will marry someone who is rich.’

Existential *wh*-conditionals have a natural correspondence to mention-some questions. We use a variant of Beck & Rullmann’s (1999) ANS_3 (28), which they propose to capture mention-some questions, to analyze existential *wh*-conditionals.¹⁰

$$(28) \quad \text{ANS}(Q)(s^*) = \lambda P \exists p [P(p)(s^*) = 1 \wedge Q(p) \wedge p(s^*) = 1]$$

When applied to an embedded mention-some question Q , ANS_3 requires Q to quantifier raise above the embedding predicate. For example, *John knows where you can buy gas* has the LF in (29).

$$(29) \quad [\text{ANS}_3(\text{where.you.can.buy.gas}) [\lambda p [\text{John knows } t_p]]]$$

In our story, questions are embedded in conditionals, since we don’t want questions to move out of the antecedent of a conditional, we need to modify (28). The simplest way is to use choice functions (Reinhart 1997). Our ANS_{some} in (30) applied to a question Q at s^* will pick out one (among many) true-at- s^* proposition in the question set. Conditionals then can work with the proposition thus obtained. Finally, we may choose to existentially close the choice function at the top. The resulting truth condition of (26) is (31), which roughly says that the place I will go (right now) is some place where I can get liquor, an intuitively adequate characterization of (26).

$$(30) \quad \text{ANS}_{\text{some}}(Q)(s^*) = f_{CH}(\lambda p [Q(p) \wedge p(s^*) = 1])$$

$$(31) \quad \llbracket (26) \rrbracket = 1 \text{ in } s^* \text{ iff } \exists f_{CH} \forall s [s \in \text{MIN}_{\#}\{s : f_{CH}(\lambda p [Q_A(p) \wedge p(s^*) = 1]) \wedge \text{PRE}(Q_C)(s) = 1\} \rightarrow \text{ANS}(Q_C)(s^*)(s) = 1]$$

¹⁰ Our account is compatible with other ways of capturing mention-some readings of questions, such as by appealing to pragmatic principles or partial answers. See Dayal To appear for relevant discussion.

Of course, the use of ANS_{some} should be constrained to avoid over-generation (not every question allows mention-some answers and not every *wh*-conditional allows existential interpretation), but these constraints are not well understood in the mention-some question literature (see [Dayal To appear](#)) and we are not going into that in the paper. But at least one prediction is made within our analysis: since *wh*-conditionals are built out of questions, whenever a question cannot receive a mention-some answer, the corresponding *wh*-conditional does not have an existential interpretation (the reverse does not hold since a *wh*-conditional might have its own constraints not discussed in the paper which would block certain mention-some questions). As far as I can see, this is a correct prediction. For example, a question like the one in (32) never allows a mention-some answer, and correspondingly the *wh*-conditional built out of it (such as (23) never has an existential interpretation.

- (32) Q: Zhangsan qing le na.liang.ge.ren?
 Zhangsan invite ASP which.two.CL.persons
 ‘Which two persons did Zhangsan invite?’
 A: #John and Mary, or Bill and Sue.

4.6 The exhaustive flavor

The consequents of *wh*-conditionals are interpreted exhaustively. Consider (33), where the exhaustive flavor is indicated by the *only/exactly* in the gloss.

- (33) Chi duoshao, jiu cheng duoshao.
 eat how.much then fill how.much
 Fill the plate with *only/exactly* the amount of food that you will eat.

Neither unselective binding nor a FR-based analysis captures this. Both of them deliver a reading that can be roughly paraphrased as *fill the plate with the amount of food that you will eat*, weaker than (33).

The exhaustive flavor does not seem due to pragmatic strengthening. First, neither universal statements nor correlatives (Hindi correlatives for example) or English free relatives are strengthened in this way. Second, the exhaustive flavour does not disappear in downward entailing contexts, in contrast to other pragmatic strengthening phenomena such as scalar implicatures which usually do ([Horn 1989](#); [Chierchia 2013](#)). Consider (34), where (33) is embedded under negation.

- (34) Zhangsan meiyou [*wh*-conditional chi duoshao, jiu cheng duoshao].
 Zhangsan not eat how.much then fill how.much
 Zs didn’t fill the plate with *only/exactly* the amount of food that you will eat.

The embedded *wh*-conditional in (34) is naturally interpreted exhaustively (indicated by *only/exactly* in the gloss), suggesting a semantic way of capturing it.

The exhaustive flavor is captured by our proposal. Suppose in s^* Lisi would eat exactly 1 pound of rice but he filled his plate with 1.5 pounds of rice. (33) is false in s^* according to our proposal. This is because the minimal situation that supports the antecedent question contains exactly 1 pound of rice, which is unable to support the consequent answer which involves 1.5 pounds of rice. For (33) to be true in s^* , Lisi would have to fill his plate with only 1 pound of rice. In other words, (33) has the exhaustive flavor according to our proposal.

It is interesting to note that our proposal has used a weak exhaustive answerhood operator to capture the so called strong exhaustiveness (strong exhaustiveness adds to weak exhaustiveness, which only contains positive information, the negative inference of *only*) (Groenendijk & Stokhof 1982). This is due to our use of minimal/exemplifying situations. Within a situation semantics, we can say that p is a strong exhaustive answer to Q in s^* iff the exemplifying/minimal situation of p also exemplifies $\text{ANS}(Q)(s^*)$, while p is a non-exhaustive answer to Q in s^* iff there is an s which is an extension of the exemplifying situation of p and s exemplifies $\text{ANS}(Q)(s^*)$. This way of capturing strong exhaustiveness is similar to the position Dayal To appear takes: p is a strong exhaustive answer to Q at w iff p is the proposition expressed by $\text{ANS}(Q)(w)$. For how to combine situation semantics with Groenendijk & Stokhof's semantics of questions, see Kratzer 2014.

4.7 Non-coreferentiality

As Lin 1999 points out, the two *wh*s in a *wh*-conditional do not always co-refer. (35) below does not mean *I will choose the shirt that you choose*. Instead, the two shirts need only to match each other for the sentence to be true in the context described in (35). More specifically, suppose that the girl is going to buy the Hermione-shirt that is hanging on the wall right in front her; then the boy had better buy the Ron-shirt that hangs next to it (Hermione-Ron and Harry-Ginny are couples in *Harry Potter*.).

- (35) [StoreX sells matching shirts for young couples. A couple came in. The boy said to the girl:]

ni xuan nage, wo jiu genzhe ni xuan nage.
 you choose which.one I then follow you choose which.one
 I will choose a shirt that matches what you choose.

Our proposal based on relations between situations (instead of relations between individuals) allows for the extra flexibility to handle non-coreferentiality: suppose the girl will buy the Hermione-shirt; the minimal antecedent situation s will consist

of *the girl*, *the Hermione-shirt* and *the boy*; since the boy cannot buy a Hermione-shirt because of a contextual sortal mismatch (because boys don't buy girls' shirts!), the Hermione-shirt's male counterpart the Ron-shirt is added to s (we can say that a matching function between shirts is salient enough in the context to be added into s ; after all, conditionals and modal expressions are highly context-dependent), and that is the shirt the boy is going to buy.

5 Conclusion

Our guiding idea is that *wh*-conditionals are interrogative conditionals, with the simple meaning that the answer to the antecedent question contains enough information to answer the consequent question. To cash out this intuition, we adopt situation semantics as a way to encode partial information; then *wh*-conditionals basically say the situation we construct out of the antecedent answer — plus presuppositions from the consequent question and some pragmatic enrichment (see the Appendix) — is enough to support the consequent answer.

Empirically, our discussion has established that a question perspective is essential to an adequate understanding of Mandarin *wh*-conditionals. The claim is supported by a wide range of interrogative properties exhibited by *wh*-conditionals such as the use of *wh*-morphology, informativity-sensitivity, uniqueness and so on. This question perspective sets our analysis apart from all existing proposals and points to a new line of research.

Theoretically, suppose *wh*-conditionals are real conditionals. They constitute another phenomenon where we can explore the interaction between alternatives and conditionals, which has been studied in unconditionals (Rawlins 2013), conditionals with disjunctive antecedents (Alonso-Ovalle 2009), and conditional questions (Isaacs & Rawlins 2008). Furthermore, while the other phenomena all involve interaction of conditionals with a single set of alternatives, the option of embedding two alternative sets within a conditional semantics has not been discussed previously. Our Q(uestion)+A(nswerhood.operator)+C(onditional) proposal illustrates how this could be done. Finally, to deal with the interaction, we could either *lift* the conditionals so that they directly work with sets of alternatives (Ciardelli 2016), or *lower* the alternative sets to single propositions so that standard semantics of conditional can work with. The Q+A+C proposal illustrates the second possibility.

Appendix: Technical details

In §3.4, we assign (36) (repeated from (17)) as the semantics of *wh*-conditionals. We now spell out the technical details of the proposal.

- (36) $\llbracket \text{ANS}(Q_A)(s^*) \text{ jiu } \text{ANS}(Q_C)(s^*) \rrbracket = 1 \text{ in } s^*$
iff $\forall s[s \in \text{MIN}\{s : \text{ANS}(Q_A)(s^*)(s) = 1 \wedge \text{PRE}(Q_C)(s) = 1\} \rightarrow$
 $\text{ANS}(Q_C)(s^*)(s) = 1]$
In words: every minimal situation that supports the answer to Q_A in s^* and
the presupposition of Q_C supports the answer to Q_C in s^* .

To see how (36) behaves, we need determine the minimal situations that support both the antecedent answer and the consequent presupposition. Consider again (37).

- (37) Zhangsan qing le shei, Lisi jiu qing le shei.
Zhangsan invite ASP who Lisi then invite ASP who
‘Lisi invited whoever Zhangsan invited.’

Suppose at last night’s party s_{37} Zhangsan invited exactly John and Mary. We first check what is the set of situations S_{37} that support both the antecedent answer and the consequent presupposition (without being minimal for now). There are many such situations: $s_1 = \text{ZHANGSAN-INVITED-JOHN-MARY-\&-LISI-INVITED-JOHN-MARY-SUE}$ ¹¹ is in S_{37} , for s_1 supports *Zhangsan invited John and Mary* (the antecedent answer) and *Lisi invited someone* (the consequent presupposition); similarly, $s_2 = \text{ZS-INVITED-JOHN-MARY-\&-LISI-INVITED-JOHN}$ is also in S_{37} .

Now we consider the minimal situations within S_{37} , $\text{MIN}(S_{37})$. Standard MIN used in situation semantics is based on part-of relation \leq_s between situations.

- (38) $\text{MIN}(S) = \{s \in S : \forall s' \in S(s' \leq_s s \rightarrow s' = s)\}$

Unfortunately, The part-of MIN in (38) does not work for our case. $\text{MIN}(S_{37})$ delivers only situations where Zhangsan invited John and Mary but Lisi invited exactly a single person. For example, $s_1 \notin \text{MIN}(S_{37})$ because there is a situation $s_3 = \text{ZS-INVITED-JOHN-MARY-\&-LISI-INVITED-SUE}$ in S_{37} that is a proper part of s_1 ; instead, $s_3 \in \text{MIN}(S_{37})$. This cannot be right: presumably we want $s_4 = \text{ZS-INVITED-JOHN-MARY-\&-LISI-INVITED-JOHN-MARY}$ to be in $\text{MIN}(S_{37})$, but part-of MIN does not allow that. I suggest we use a cardinality-based $\text{MIN}_\#$ instead.

- (39) $\text{MIN}_\#(S) = \{s \in S : \forall s' \in S(|s'| \leq |s| \rightarrow |s'| = |s|)\}$

$\text{MIN}_\#$ checks the cardinality of the atomic participants — these are *thin particulars*, individuals abstracted away from their properties — in a situation.¹² For example,

¹¹ We use small capitals to refer to situations. $\text{ZHANGSAN-INVITED-JOHN-MARY-\&-LISI-INVITED-JOHN-MARY-SUE}$ is the situation that exemplifies/minimally-supports the proposition *that Zhangsan invited John and Mary, and Lisi invited John, Mary and Sue*.

¹² $\text{MIN}_\#$ is related to one of the two aspects of minimality – the *individual minimality* – discussed in Van Benthem 1989. Individual minimality itself comes from *Logic Programming* (Lloyd 2012). For instance, Prolog programs are supposed to ‘contain no individuals/objects except for those which are explicitly named in the language of the program’ (Van Benthem 1989: 334).

$|s_1| = 5$ for there are 5 participants — zs, john, mary, ls, sue, while $|s_4| = 4$ for there are 4 — zs, john, mary, ls; consequently s_4 but not s_1 is likely to be in $\text{MIN}_\#(S_{37})$.

It turns out the minimal number of participants a s in S_{37} can have is 4: every s in S_{37} supports the antecedent answer, so s has zs, john, mary, and to support the consequent presupposition s need include ls as well. As a result, every s in $\text{MIN}_\#(S_{37})$ has 4 atomic participants. There are exactly seven such situations in $\text{MIN}_\#(S_{37})$.

$$(40) \quad \text{MIN}_\#(S_{37}) = \left\{ \begin{array}{l} \text{ZS-INVITED-J-M-\&-LS-INVITED-J,} \\ \text{ZS-INVITED-J-M-\&-LS-INVITED-M,} \\ \text{ZS-INVITED-J-M-\&-LS-INVITED-J-M,} \\ \text{ZS-INVITED-J-M-\&-LS-INVITED-ZS,} \\ \text{ZS-INVITED-J-M-\&-LS-INVITED-ZS-J,} \\ \text{ZS-INVITED-J-M-\&-LS-INVITED-ZS-M,} \\ \text{ZS-INVITED-J-M-\&-LS-INVITED-ZS-J-M} \end{array} \right\}$$

(40) still does not quite work. The semantics for *wh*-conditionals in (36) would require every s in (40) to support the consequent answer. This cannot happen since the consequent answer (relativized to an evaluation situation) is usually unique.

I propose that the antecedent situations, besides being in $\text{MIN}_\#(S_{37})$ (that is, besides being the minimal situations that satisfy both the antecedent answer and the consequent presupposition), have to satisfy two more constraints.

The first constraint comes from the idea that the presupposition of the antecedent question (*that Zhangsan invited someone*) alone should not provide any information that contributes to answering the consequent question — for if it were able to, a simpler form such as *Lisi invited Zhangsan* would have been used to answer the consequent question. In other words, we should discard any situation in S_{38} where *that Lisi invited Zhangsan* comes out true. Essentially, this is a constraint that favors constructing the antecedent situations using new instead of old (presupposed) information. Here, I will however not try to formalize the constraint but simply use NO.OLD to represent it.¹³ (41) below illustrates how it works.

$$(41) \quad \text{MIN}_\#(S_{37} \cap \text{NO.OLD}(s)) = \left\{ \begin{array}{l} \text{ZS-INVITED-J-M-\&-LS-INVITED-J,} \\ \text{ZS-INVITED-J-M-\&-LS-INVITED-M,} \\ \text{ZS-INVITED-J-M-\&-LS-INVITED-J-M} \end{array} \right\}$$

The second constraint involves the idea that the antecedent should not contain redundant information. In other words, every bit of new information conveyed by the

¹³ Formalizing NO.OLD is doable. First, we take the set of situations that support the presuppositions of Q_A and $Q_C - \{s : \text{PRE}(Q_A)(s) \wedge \text{PRE}(Q_C)(s)\}$. We then apply $\text{MIN}_\#$ to the set as what we did to S_{80} ; this gives us the unit set $\{\text{ZS-INVITED-J-M-\&-LS-INVITED-ZS}\} = \text{MIN}_\#\{s : \text{PRE}(Q_A)(s) \wedge \text{PRE}(Q_C)(s)\}$. Finally, NO.OLD in the case of S_{80} requires that none of the situations in S_{80} contain a subsituation that itself is a subsituation of any situation in $\text{MIN}_\#\{s : \text{PRE}(Q_A)(s) \wedge \text{PRE}(Q_C)(s)\}$. This is complicated, and I believe an intuitive understanding of NO.OLD suffices.

antecedent should be used to construct the antecedent situation. This can be translated as a maximality requirement: among the situations in (41) constructed from previous steps, the largest one gets selected since it contain the most information.

Putting everything together, we have (42) as the semantics of *wh*-conditionals, with the underlined part encoding the maximality requirement.

$$(42) \quad \begin{aligned} & \llbracket \text{ANS}(Q_A)(s^*) \text{ jiu } \text{ANS}(Q_C)(s^*) \rrbracket = 1 \text{ in } s^* \text{ iff} \\ & \forall s \llbracket s \in \text{MIN}_{\#} \{s : \text{ANS}(Q_A)(s^*)(s) = 1 \wedge \text{PRE}(Q_C)(s) = 1 \wedge \text{No.Old}(s)\} \wedge \\ & \quad \neg \exists s' [s' \in \text{MIN}_{\#} \{s : \text{ANS}(Q_A)(s^*)(s) = 1 \wedge \text{PRE}(Q_C)(s) = 1\} \wedge s <_s s'] \rrbracket \\ & \quad \underline{\rightarrow \text{ANS}(Q_C)(s^*)(s) = 1} \end{aligned}$$

Applying (42) to s^*_{37} , we get {ZS-INVITED-J-M-&-LS-INVITED-J-M} as the set of antecedent situations. (42) then requires every situation within the set should support the consequent answer. We thus correctly predict that Lisi cannot invite people other than John and Mary.

There is a last concern: suppose in a different scenario s^*_{39} Zhangsan invited John and Mary, but Lisi invited only John. The intuition is that (37) is false in this case. Our semantics so far predicts the contrary: the minimal antecedent situation s we get (with the two constraints just discussed) is ZS-INVITED-J-M-&-LS-INVITED-J-M. s supports the consequent answer *that Lisi invited John*, and thus the *wh*-conditional in (37) is incorrectly predicted to be true. To deal with this problem, I propose *wh*-conditionals further require that the minimal antecedent situation we get does not contain subsituations that themselves support both the antecedent answer and the consequent answer. This part is underlined in (43).

$$(43) \quad \begin{aligned} & \text{Semantics of } wh\text{-conditionals:} \qquad \qquad \qquad \text{Official} \\ & \llbracket \text{ANS}(Q_A)(s^*) \text{ jiu } \text{ANS}(Q_C)(s^*) \rrbracket = 1 \text{ in } s^* \text{ iff} \\ & \forall s \llbracket s \in \text{MIN}_{\#} \{s : \text{ANS}(Q_A)(s^*)(s) = 1 \wedge \text{PRE}(Q_C)(s) = 1 \wedge \text{No.Old}(s)\} \wedge \\ & \quad \neg \exists s' [s' \in \text{MIN}_{\#} \{s : \text{ANS}(Q_A)(s^*)(s) = 1 \wedge \text{PRE}(Q_C)(s) = 1\} \wedge s <_s s'] \rrbracket \\ & \quad \rightarrow [\text{ANS}(Q_C)(s^*)(s) = 1 \wedge \\ & \quad \underline{\neg \exists s'' [s'' <_s s \wedge \text{ANS}(Q_A)(s^*)(s'') = 1 \wedge \text{ANS}(Q_C)(s^*)(s'') = 1}]] \end{aligned}$$

(43) solves the problem with s^*_{39} : the antecedent situation ZS-INVITED-J-M-&-LS-INVITED-J-M contains a subsituation ZS-INVITED-J-M-&-LS-INVITED-J that supports both the antecedent answer (*that Zhangsan invited John and Mary*) and the consequent answer (*that Lisi invited John*), violating the underlined part in (43), and thus the *wh*-conditional is predicted to be false in this scenario.

The formula in (43) is complicated, but I believe a large part of it should belong to pragmatics, such as old information does not count, every bit of new information should be used, and no redundant information should be provided. We thus backgrounded these components in the main text in §3, trading perspicuity for precision. The semantics in (17) is sufficient for the discussion in §4.

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Mandarin *wh*-conditionals as interrogative conditionals

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